Original Research Article

Assessment of Physico-Chemical Properties of Soil from Different Blocks of Sahibganj district, Jharkhand, India

ABSTRACT

An evaluation of Physico-chemical properties of 27 soil samples from 3 different blocks *ie.,* Sahibganj, Borio and Taljhari of Sahibganj district (Jharkhand) in different depths (0–15, 15–30 and 30–45 cm) was carried out during the year of 2022. The present investigation was objectified as determination of soil Physico-chemical properties to analyse the soil fertility status with finding out the deficiency and toxicity of different soil nutrients. Soil samples were analysed using standard laboratory techniques and statistical analysis. The bulk density of the soils varied from 1.13 to 1.53 Mg m^{-3}, while the particle density ranged from 2.24 to 2.69 Mg m^{-3}. In soils, the percentage of pore space was between 36.88 and 49.55% and water holding capacity was between 31.11 and 44.71%. Soil pH varies from 6.28 to 7.90 which was neutral to slightly saline with soil EC ranged 0.02-0.64 dS m^{-1} significantly affect for better crop production. In the case of the organic carbon, nitrogen and phosphorus content of research area was found to be low to medium while the range of Potassium was sufficient ranges from 176.34 to 271.77 kg ha^{-1}.

.

Keywords: Borio, Sahibganj, Soil fertility, Physico-chemical, Properties, Taljhari

INTRODUCTION

Soil is a dynamic, 3-dimensional natural body of the landscape developed from the weathering of rocks through various pedogenic processes, consisting of mineral and organic constituents processing a definite set of physical, chemical and biological properties, having a variable depth covering the surface of earth & providing a medium for growth of the terrestrial plant (Verma *et al.,* 2019).

The global drive for sustainable agricultural systems involves optimizing agricultural resources to satisfy human needs and at the same time maintaining the quality of the environment and sustaining natural resources. The concept of soil health and soil quality has consistently evolved with an increase in the understanding of soils and soil quality attributes. The deficiency of nutrients has become major constraint to productivity, stability and sustainability of soils (Chaudhary *et al.*, 2013).

Soil quality encompasses many properties and processes as the structural stability of the aggregates water retention capacity of soils and capability of nutrient cycling. Of the several elements known to be essential for plant growth, macronutrients (N, P, K) Because of imbalanced and inadequate fertilizer are coupled with low efficiency of other inputs, the response (production) efficiency of chemical fertilizer nutrients has declined rapidly under intensive agriculture in recent years. (Singh *et al.*, 2017)

Sahibganj district encompasses northern Gangetic plains to the borders of Bengal in the South. This district contains Rajmahal hills and other ranges. A large part of the district is hilly. The vast tract of land enclosed between hill ranges had been assigned a name Damin-I-koh which is a Persian word means skirts of the hills. The region on the banks of the Ganges is fertile and richly cultivated. The district may be divided into two natural division on the basis of geographical location and cultivable land. First region consists of Borio, Mandro, Barhait, Pathna and Taljhari which lies under Damin-I-koh area. The hills and slopes are covered with forests and valleys have cultivable lands yielding mostly paddy. The second region consists of Sahibganj, Udhwa and Barharwa blocks. The Ganges, Gumani and Bnsloi rivers flow through this region. This area has plenty of fertile lands and is richly cultivated. Clayey loam type alluvial soil occurs near Sahibganj plains.

MATERIALS AND METHODS

Sahibganj is located on the north-east of Jharkhand and situated on the banks of Ganges. It lies between 25°23’81’’N latitude and 87°64’54” E longitude and is located at an average elevation of 77 m above the mean sea level. The total land area of the district is 1599.00 sq. km. A large part of the district is hilly. The region on the bank of the Ganges is fertile and richly cultivated. The area for the research study involves 3 blocks of Sahibganj district *i.e.*, Sahibganj, Borio and Taljhari. Soil samples were collected during kharif season of 2021from 9 different villages of 3 blocks of Malda district in 3 different depths i.e., 0-15 cm, 15-30 cm and 30-45 cm by the help of

augar and khurpi. Soil samples were analysed using different standard laboratory techniques and statistical analysis of using Completely Randomised Design (CRD). Bulk Density, Particle Density, Porosity and Water Retaining Capacity were measured by the help of Muthuaval *et al.,* (1992), method using graduated measuring cylinder. Colours of soil samples were determined by using Munsell Colour Chart and Textural classes were assessed by using Bouyoucos Hydrometer. Chemical properties such as Soil pH (1:2) and Electrical Conductivity (1:2) were determined by Digital pH Meter and Digital Conductivity Meter respectively. Soil organic Carbon was evaluated by Wet Oxidation method given by Walkley and Black (1947). Estimation of Nitrogen was done by Alkaline KMnO4 Method of Subbiah and Asija (1956). Assessment of Phosphorus was completed by using Photometric Colorimeter (Olsen *et al.,* 1954) and Potassium by Flame Photometer while heavy metals were determined using DTPA method (Lindsey and Norvell, 1978).

RESULT AND DISCUSSION

Physical properties of soil:

Bulk density (Mg m^{-3}): The table 1 and fig. 1 depicted that the maximum bulk density was recorded in Rampur village of Taljhari blocks (B_3V_2) 1.51, 1.53 and 1.53 Mg m^{-3} at depth 0-15, 15-30 and 30-45 cm and minimum bulk density recorded in Makhmalpur village of Sahibganj blocks (B_1V_3) is 1.13, 1.17 and 1.18 Mg m^{-3}

Particle density (Mg m^{-3}): The table 1 and fig.1 depicted that the maximum particle density was found in Lilatanr (B_2V_1) is 2.65, 2.67 and 2.69 Mg m^{-3} with depth 0-15,15-30 and 30-45 cm and the minimum particle density found in Makhmalpur (B_1V_3) is 2.24, 2.26 and 2.30 Mg m^{-3} with depth 0-15,15-30 and 30-45 cm.

Percent Pore Space (%): The table 1 and fig. 1 depicted that the maximum percent pore space found in village Hajipur (B_1V_2) is 49.55, Kodarjana (B_1V_1) is 48.47 and Makhmalpur (B_1V_3) is 49.14 % at depth 0-15, 15-30 and 30-45 cm. The minimum percent pore space found in village Rampur (B_3V_2) 37.60, 37.29 and 36.88% with depth 0-15, 15-30 and 30-45 cm.

Water Holding Capacity (%): The table 1 and fig. 1 depicted that maximum water holding capacity (%) found in Hajipur (B1V2) is 44.71, 43.29 and 42.96 % at depth 0-15, 15-30 and 30-45 cm. The minimum value of water holding capacity (%) found in Gutibara (B3V3), Rampur (B3V2) and Rampur (B3V2) 31.18, 31.23 and 31.11 % at depth 0-15, 15-30 and 30-45 cm respectively.

Chemical properties:

Soil pH (w/v): The table 2 and fig. 2 depicted that the maximum pH values with recorded in Makhmalpur (B_1V_3), Lilatanr (B_2V_1) and Lilatanr (B_2V_1) is 7.53, 7.90 and 7.90 at the depths of 0-15, 15-30 and 30-45 cm and the maximum pH values with recorded Pathlahra (B_2V_3), Rampur (B_3V_2) and Kodarjana (B_1V_1) is 6.30, 6.55 and 6.58 at the depths of 0-15, 15-30 and 30-45 cm respectively.

EC (dS m^{-1}): The table 2 and fig. 2 depicted that the soil sample from Hajipur (B_1V_2) had the highest EC values which is 0.61, 0.64 and 0.65 ds m^{-} at depths of 0-15, 15-30 and 30-45 cm respectively and the soil sample from Pathlahra (B_2V_3) had the lowest EC values which is 0.02, 0.05 and 0.05 ds m^{-1} at depths of 0-15, 15-30 and 30-45 cm respectively.

Organic carbon (%): The table 2 and fig. 2 depicted that the maximum value of organic carbon percent is found in soil of Jetkumarjori (B_2V_2), Jetkumarjori (B_2V_2) and Jetkumarjori (B_2V_2) is 0.483, 0.477 and 0.471 % with depth 0-15, 15-30 and 30-45 cm and minimum value in soil of Pathlahra (B_2V_3), Pathlahra (B_2V_3) and Brindaban (B_3V_1) is 0.416, 0.409 and 0.347 % with depth 0-15, 15-30 and 30-45 cm respectively.

Available Nitrogen (kg ha^{-1}): The table 3 and fig. 3 depicted that the maximum value of nitrogen is found in soil of Lilatanr (B_2V_1) is 407.80, 397.30 and 294.20 kg ha^{-1} respectively with depth 0-15, 15-30 and 30-45 cm and minimum value in soil of Brindaban (B_3V_1), Gutibara (B_3V_3) and Gutibara (B_3V_3) is 223.78, 214.52 and 208.97 kg ha^{-1} with depth 0-15, 15-30 and 30-45 cm respectively.

Available phosphorus (kg ha^{-1}): The table 3 and fig. 3 depicted that the maximum value of phosphorus is found in soil of Makhmalpur (B_1V_3) is 43.79, 39.37 and 38.68 kg ha^{-1} with depth 0-15, 15-30 and 30-45 cm respectively and minimum value in soil of Kodarjana (B_1V_1), Rampur (B_3V_2) and Jetkumarjori (B_2V_2) is 21.45, 21.03 and 23.20 kg ha^{-1} 0-15, 15-30 and 30-45 cm respectively.

Available Potassium (kg ha^{-1}): The table 3 and fig. 3 depicted that the maximum value of potassium is found in soil of Pathlahra (B_2V_3) Jetkumarjori (B_2V_2) Makhmalpur (B_1V_3) is 277.45, 271.84 and 266.23 kg ha^{-1} with depth 0-15, 15-30 and 30-45 cm and minimum value in soil of Kodarjana (B_1V_1) Gutibaram (B_3V_3) Gutibara (B_3V_3) is 186.12, 179.45 and 176.34 kg ha^{-1} with depth 0-15, 15-30 and 30-45 cm respectively.

Conclusion

It is concluded that the soils from the Sahibganj, Borio and Taljhari blocks of Sahibganj district texture was found clay loam, silty clay and sandy clay loam. Bulk density, Particle density, percentage Pore Space and water holding capacity were found suitable for the crop production. The pH was found slightly acidic to saline in nature. The percentage organic carbon and Available Nitrogen is high in Kodarjana, Phosphorus was highest in Makhmalpur and Potassium is high in Pathlahra. Recommended fertilizer doses should be applied as per Soil Test Crop Response to prevent yield losses due to deficiency of nutrients Therefore, experience gained through this study in future to help the farmers regarding the quality high yield production and maintain better soil health.

References:

1. Bouyoucos GJ. The hydrometer as a new method for the mechanical analysis of soils. Soil Sciences 1927;23:343- 353.

2. Chaudhari PR, Ahire DV, Ahire VD, Chakravarty M, Maity S. Study of Soil bulk density as related to soil texture, organic matter contents and available total nutrients of Coimbatore soil. International Journal of Scientific and Research publications. 2013;3(2):1-8.

3. Chesnin L, Yien CH. Turbidimetric determination of available sulphur. Proceeding of Soil Science. American. 1950;14:149-151.
4. Ghosh C, Mukherjee M, Biswas K. Physico-chemical Properties of Soil of Jaldapara National Park in West Bengal, India. International Journal of Advanced Research in Biological Sciences.2020;7(6):141-150.
5. Gupta PK. Soil, plant, water and Fertilizer Analysis, Agro Botanica, Bikaner 1999.
6. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi 1973.
7. Karmakar A, Mandal P, Adhikary R, Mandal V. Assessment of Rhizospheric Arbuscular Mycorrhizae Spores in Relation to Soil Characters in the Rice Fields of Malda District, India. Russian Agricultural Sciences. 2020;46(1):48-55.
8. Muhr GR, Datta NP, Shankara Subraney N, Dever F, Lecy VK, Donahue RR. Soil Testing in India, USAID Mission to India 1965.
9. Munsell AH. Munsell Soil Colour Charts. First edition. Munsell Color Company Inc., Baltimore 1954.
10. Muthuvel P, Udayasoorian C, Natesan R, Ramaswami PR. Introduction to Soil Analysis. First edition. Tamil Nadu Agricultural University, Coimbatore 1992.
11. Olsen SR, Cole CV, Watnahe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate, U. S. Department of Agriculture Circular 1954, 93.
12. Panwar P, Pal S, Reza SK, Sharma B. Soil Fertility Index, Soil Evaluation Factor, and Microbial Indices under Different Land Uses in Acidic Soil of Humid Subtropical India. Communications in Soil Science and Plant Analysis 2011;42(22):2724-2737.
13. Singh YV, Shashi Kant, Singh SK, Sharma PK, Jat Kumar M, Shahi SK, et al. Assessment of Physico- chemical Characteristics of the Soil of Lahar Block in Bhind District of Madhya Pradesh (India). International Journal of Current Microbiology and Applied Sciences. 2017;6(2):511-519.
14. Subbiah BV, Asija CL. A rapid procedure for the estimation of available nitrogen in soils, Current Science 1956;25:259-260.
15. Toth SJ, Prince AL. Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique, Soil Science Journal 1949;67:439-445.

16. Verma C, Lal A, David ADM, Rao PS. Determination of Physico-chemical Properties in Soil Samples of Prayagraj (Allahabad) District, Uttar Pradesh, India. Asian Journal of Applied Chemistry Research. 2019;4(2):1-8.
17. Walkley A. Critical examination of rapid method for determining organic carbon in soils, effect of variation in digestion conditions and of inorganic soil constituents, Soil Science 1947;632:251.
18. Wilcox LV. Electrical Conductivity, America Water Association journal 1950;42:775-776.
19. Gangopadhyay, S.K., Sarkar D., Sahoo, A.K. and Das, K. (2005) Forms and distribution of potassium in some soils of Ranchi plateau. Journal of the Indian Society of Soil Science 53, 413-416.
20. Nayak, D.C., Bandyopadhyay, S., Sahoo, A.K., Reza, S.K. and Singh, S.K. (2017) Characterization of some cracking clay soils of Rajmahal Trap in Sahibganj representing intermediate zone of Jammu region. District, Jharkhand. Clay Research 36, 55-63.
21. Mishra, R. K. (2004) Planning for Food and Nutritional Security in Jharkhand, Published by Agricultural Data Bank, BAU, Ranchi, Jharkhand, p. 275

Table 1: Bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore Space (%) and water holding capacity (%) of soil at different depth

Name of Village and Farmer's Field		Bulk density (Mg m^{-3})			Particle density (Mg m^{-3})			Pore Space (%)			Water holding capacity (%)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Sahibganj (B_1)	**B_1V_1**	1.15	1.18	1.20	2.27	2.29	2.32	49.33	48.47	48.27	43.97	42.51	42.13
	B_1V_2	1.19	1.22	1.22	2.35	2.36	2.39	49.36	48.30	48.05	44.71	43.29	42.96
	B_1V_3	1.13	1.17	1.18	2.24	2.26	2.30	49.55	48.23	49.14	42.79	41.49	40.48
Borio (B_2)	**B_2V_1**	1.51	1.52	1.52	2.65	2.67	2.69	43.01	41.41	40.89	40.14	40.78	39.48
	B_2V_2	1.36	1.38	1.38	2.56	2.57	2.57	46.87	46.30	46.30	40.30	39.28	39.03
	B_2V_3	1.31	1.35	1.37	2.54	2.56	2.61	48.42	47.26	47.05	39.09	38.28	38.07
Taljhari (B_3)	**B_3V_1**	1.49	1.51	1.52	2.51	2.52	2.55	40.63	40.07	40.03	35.52	34.27	34.16
	B_3V_2	1.51	1.53	1.53	2.42	2.44	2.47	37.60	37.29	36.88	32.12	31.23	31.11
	B_3V_3	1.47	1.49	1.50	2.52	2.53	2.53	41.66	41.10	40.71	33.18	32.22	32.08
F- test		S	S	S	S	S	S	S	S	S	S	S	S
S.Em. (±)		0.035	0.023	0.026	0.024	0.035	0.038	0.044	0.903	0.671	0.717	0.525	0.464
C. D. (P =0.05)		0.106	0.069	0.077	0.073	0.106	0.113	0.131	2.684	1.996	2.131	1.140	1.379

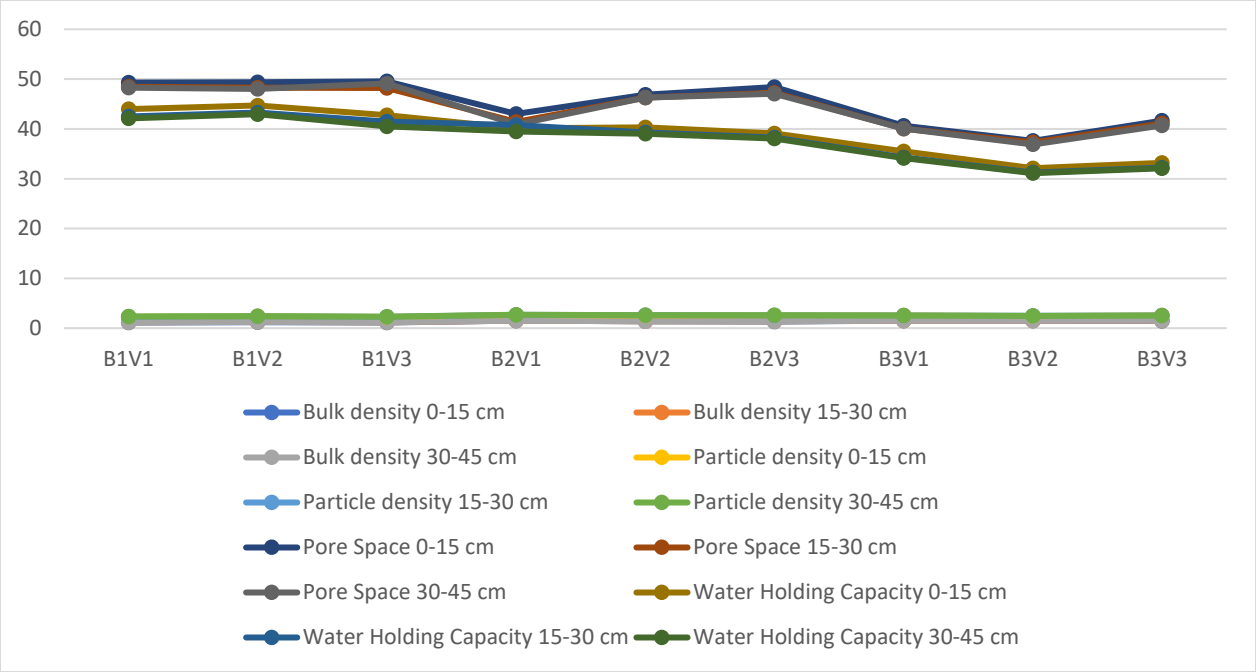

Fig. 1. Bulk density (Mg m^{-3}), particle density (Mg m^{-3}), pore Space (%) and water holding capacity (%) of soil at 0-15, 15-30 and 30-45 cm depth

Table 2: pH(w/v), EC (dS m^{-1}) and organic carbon (%) of soil at different depth.

Name of Village and Farmer's Field		pH(w/v)			EC (dS m^{-1})			Organic carbon (%)		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Sahibganj (B_1)	**B_1V_1**	6.44	6.65	6.58	0.36	0.38	0.33	0.457	0.451	0.448
	B_1V_2	6.70	6.80	6.80	0.61	0.64	0.65	0.425	0.419	0.414
	B_1V_3	7.53	7.68	7.61	0.22	0.27	0.25	0.449	0.442	0.433
Borio (B_2)	**B_2V_1**	7.70	7.90	7.90	0.06	0.07	0.07	0.427	0.421	0.417
	B_2V_2	6.28	7.31	7.49	0.10	0.10	0.11	0.483	0.477	0.471
	B_2V_3	6.30	6.90	6.90	0.02	0.05	0.05	0.416	0.409	0.406
Taljhari (B_3)	**B_3V_1**	6.60	6.80	6.80	0.07	0.09	0.08	0.458	0.453	0.347
	B_3V_2	6.35	6.55	6.62	0.41	0.39	0.38	0.438	0.434	0.428
	B_3V_3	6.46	6.67	6.73	0.34	0.29	0.27	0.441	0.433	0.430
F- test		S	S	S	S	S	S	S	S	S
S.Em. (±)		0.110214	0.903	0.671	0.903	0.671	0.717	0.717	0.903	0.671
C. D. (P =0.05)		2.684	1.996	2.131	2.684	1.996	2.131	2.131	2.684	1.996

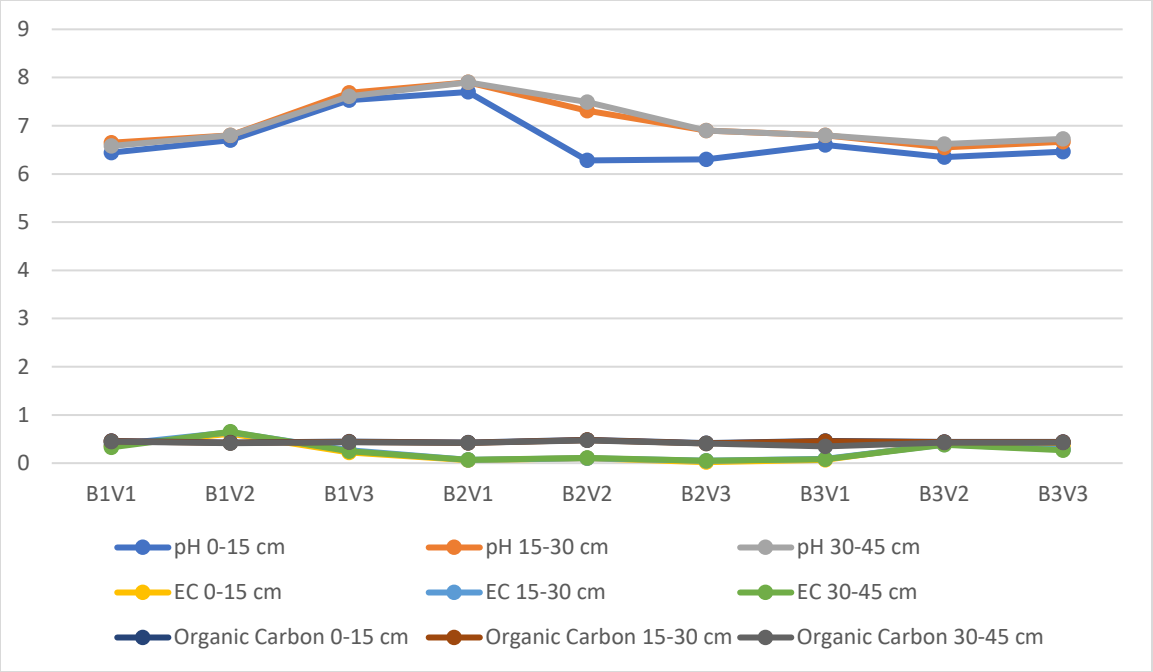

Fig. 2. pH(w/v), EC (dS m^{-1}) and organic carbon (%) of soil at 0-15, 15-30 and 30-45 cm depth.

Table 3: Available nitrogen (kg h^{-1}), available phosphorus (kg h^{-1}) and available potassium (kg h^{-1}) of soil at different depth.

Name of Village and Farmer's Field		Available Nitrogen (kg h^{-1})			Available phosphorus (kg h^{-1})			Available Potassium (kg h^{-1})		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Sahibganj (B_1)	**B_1V_1**	309.64	297.13	292.46	21.45	23.62	27.73	229.16	247.45	243.57
	B_1V_2	286.26	277.83	275.27	39.32	35.83	34.37	245.47	239.63	235.45
	B_1V_3	313.73	308.28	303.82	43.79	39.37	38.68	271.77	267.12	266.23
Borio (B_2)	**B_2V_1**	407.80	397.30	394.20	31.62	37.37	35.36	246.89	239.85	237.27
	B_2V_2	376.38	369.82	362.03	26.70	23.39	23.20	263.52	271.84	235.56
	B_2V_3	398.39	387.08	384.26	38.27	35.39	34.32	277.45	265.78	259.37
Taljhari (B_3)	**B_3V_1**	241.86	238.54	236.76	35.76	32.73	31.27	219.78	214.74	209.75
	B_3V_2	254.85	249.74	246.85	24.37	21.03	23.87	226.85	219.42	214.86
	B_3V_3	223.78	214.52	208.97	31.17	28.84	26.28	186.12	179.45	176.34
F- test		S	S	S	S	S	S	S	S	S
S.Em. (±)		3.130899	0.903	0.671	0.717	0.903	0.671	0.717	0.903	0.671
C. D. (P =0.05)		9.302378	2.684	1.996	2.131	2.684	1.996	2.131	2.684	1.996

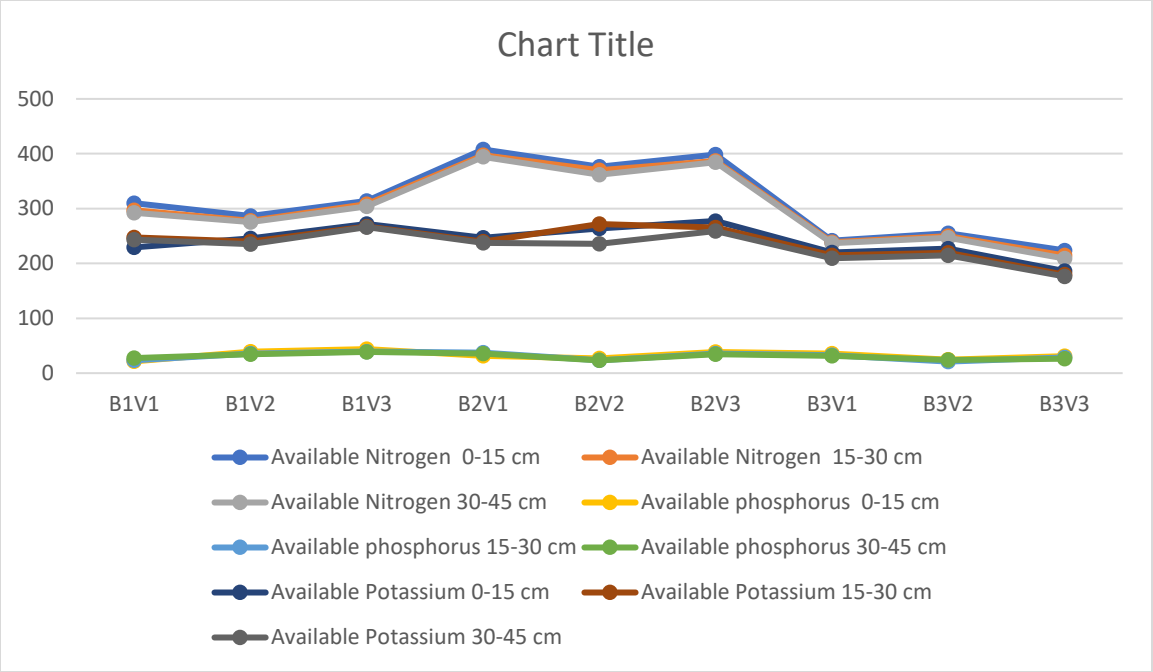

Fig. 3. Available nitrogen (kg h^{-1}), available phosphorus (kg h^{-1}) and available potassium (kg h^{-1}) of soil at 0-15, 15-30 and 30-45 cm depth.